MARINE BENTHIC ALGAE FROM ADDU ATOLL, MALDIVE ISLANDS

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D. Marine benthic algae from Addu Atoll, Maldive Islands[1/]

by Roy T. Tsuda[2/] and Jan Newhouse[2/]

The following is an annotated list of the marine benthic algae that were sent to the senior author by Mr. David C. Sigee. One terrestrial and one freshwater alga are also included in this paper. All collections were made in the proximity of three islands--Gan, Hitaddu, and Fedu on Addu Atoll, July to September, 1964.

Past published listings of the algae from the Maldive Islands are based solely on the collections from two expeditions--the J. S. Gardiner Expedition, 1892-1900, and the J. Murray Expedition, 1933-34. Barton (1903) describes 6 species, including 4 forms, 3 of the species from Addu Atoll; while Foslie (1903) enumerates 9 species of melobesioid algae, containing various forms, 2 of the species from Addu Atoll. Newton (1953) records one alga, Microdictyon pseudohapteron f. luciparense Setchell, collected by the J. Murray Expedition from Mulakadu Atoll. To the authors' knowledge, only these three papers treat the marine benthic algae from the Maldive Islands.

HABITAT DATA

The following is a list of habitats on Addu from which the collections of algae were made or observed by Mr. Sigee.

A. Gan Island - lagoon reef flat, shoreline to 100 feet.
B. Gan Island - lagoon reef flat, 100 feet to 250 feet.
C. Gan Island - lagoon reef flat, 250 feet to reef edge (360 feet).
D. Gan Island - lagoon reef slope, to depth of 90 feet.
E. Gan Island - seaward reef flat, shoreline to boulder zone.
F. Gan Island - seaward reef flat, boulder zone to reef edge.
G. Hitaddu Island - seaward reef flat, shoreline to 20 feet.
H. Hitaddu Island - seaward reef flat, 20 feet to reef edge.
I. Gan-Fedu Gap.
J. On knoll in lagoon, 30 feet below the surface.

MARINE ALGAE

In the list of species below, the letters representing the habitats above refer both to the site where the species were actually collected and where the species were only observed. Where more than one habitat is listed for a species, there is no available information indicating which was the actual site of collection. It must be assumed that the collector was sufficiently competent to judge critical differences between the specific entities represented. All specimen numbers

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cited here are those of the collector, and the specimens are deposited in the herbarium of Dr. Maxwell S. Doty, University of Hawaii.

Those five species which are recorded from Addu Atoll in both Barton (1903) and Foslie (1903) are incorporated in this listing and preceded by an asterisk.

Myxophyceae

Anacystis montana (Lightf.) Drouet & Daily
Habitat: E, Sigee 120.

Calothrix pilosa Bornet & Flahault
Habitat: E, Sigee 120.

Hormothamnion enteromorphoides Bornet & Flahault
Habitat: A, E, Sigee 86.
This species determination was made by Dr. Francis Drouet.

Lyngbya aestuarii Gomont
Habitat: B, C, E, Sigee 26, 79, 87.

Lyngbya majuscula Gomont
Habitat: A-F, Sigee 16.

Schizothrix calcicola (Ag.) Gomont
Habitat: E, Sigee 88.

Symploca hydnoides Gomont
Habitat: A-F, Sigee 42, 46, 61, 71, 79, 84, 85.

Chlorophyceae

Boergesenia forbesii (Harvey) Feldmann, 1938: 588, figs. 3-5.
Habitat: A, B, E, F, Sigee 6.
The elongated vesicles are in groups of 10-20. The bases of the vesicles in this collection are tapered with attached septate rhizoids.

Boodlea composita (Harv.) Brand, 1905: 187; Egerod, 1952: 362, figs. 6a, pl. 32a.
Habitat: B, E, F, H, Sigee 94.
Both specimens seem to fall within the limits of this species. No. 7 is much coarser with the main axis about 300 μ in diameter, while the main axis of No. 94 is about half that diameter.

Boodlea sp.
Habitat: D, Sigee 63.
The collection is a fine spongiose mass about a centimeter in diameter, with the presumed older portions of filaments approximately 25 μ in diameter and the younger portions as fine as 7 μ.

Bryopsis pennata Lamx., 1809: 134, fig. 1a-b, pl. 3; Egerod, 1952:370, fig.7.
Habitat: A-F, Sigee 14, 54, on coral.

Caulerpa lentillifera J. Ag., 1837: 173; Eubank, 1946: 418, fig. 2L; Taylor, 1950: 67.
Habitat: A-D, Sigee 8b.
This specimen, which is 5 mm high from the prostrate axis, does not fall within the size range as described by Eubank (1946) or Taylor (1950), but is placed here because of its distinct constrictions at the points of attachment of the pedicels to the terminal heads.

Caulerpa racemosa var. macrophysa (Kütz.) Taylor, 1928: 101, pl. 12 (fig.3) and pl. 13 (fig. 9).
Habitat: A-D, Sigee 8a.

Caulerpa racemosa var. peltata (Lamx.) Eubank, 1946: 421, figs. 2r-s.
Habitat: A-C, F, H, Sigee 9, 13.
Distinct peltate ramuli are present on both specimens.

Caulerpa serrulata var. typica (Weber-van Bosse) Tseng, 1936: 178, pl. 1.
Habitat: I, Sigee 47.

Caulerpa taxifolia (Vahl) Ag., 1822: 435; Eubank, 1946: 417, fig. 2f-g.
Habitat: A-C, Sigee 10.

Chaetomorpha brachygona Harvey, 1858: 87; Taylor, 1960: 70, pl. 2(fig.9).
Habitat: A, Sigee 66.
The filaments are about 150 μ in diameter and slightly constricted at their septa. The cells are less than two times as long as their diameter.

Chaetomorpha crassa (Ag.) Kütz., 1845: 204; Taylor, 1960: 72.
Habitat: A, Sigee 106.
The filaments, including the cell wall, are about 420 μ in diameter with the cell length less than twice their diameter. The thick cell wall is approximately 75 μ in diameter.

Chaetomorpha gracilis Kütz., 1845: 203; Taylor, 1960: 70.
Habitat: G, Sigee 105.
These filaments are about 45 μ in diameter with the length of the cells about two to four times as long as their diameter.

Cladophora sp.
Habitat: B-E, Sigee 38, 55.
These intertangled filaments are light brown in color with their cells about 120 μ in diameter. The length of each cell is about seven to eight times their diameter. The lateral branches usually occur on one side of the main filament.

Cladophora sp.
Habitat: A-B, Sigee 73.

Cladophoropsis sp.
Habitat: F, H, Sigee 99, 118.
The lateral filaments are spaced irregularly along the main filament in a verticillate manner. The diameter of the main filament is about 550 μ.

Codium arabicum Kütz., 1856: 35, pl. 100 (fig. II).
Habitat: F, Sigee 123.

Codium edule Silva in Egerod, 1952: 392, fig. 18, pl. 35b.
Habitat: B, F, Sigee 22.
A branching repent specimen with the thalli not secondarily attached to each other. The size and shape of the utricles are very similar as those described in Egerod (1952).

Dictyosphaeria intermedia var. intermedia Weber-van Bosse, 1905; Taylor, 1950: 42.
Habitat: E, F, H, Sigee 40.
Two morphologically different thalli are included in this collection--a solid, pseudoparenchymatous cushion and a hollow monostromatic bladder. Both thalli lack trabeculae. The latter thallus also falls within the circumscription of D. cavernosa (Forsskål) Boerg. Egerod (1952) comments on these species saying that D. intermedia, in the later stages of development, is almost indistinguishable from D. cavernosa. Since these two thalli appear under the same collection number, it may be possible that these represent the young and old stage of D. intermedia. A more critical study of the haptera of both species is needed.

Enteromorpha sp.
Habitat: A, D, Sigee 68.
These thalli are about 7 cm high with branching occurring near the base. Both cylindrical and compressed branches arise from the base, with the former type about 150 μ in diameter and the latter type about 1 mm in diameter. The cells appear in longitudinal rows with two to four pyrenoids in each cell.

Halimeda discoidea Decaisne, 1842: 91; Hillis, 1959: 352, pl. 2 (fig. 5), pl. 5 (fig. 11), pl. 6 (fig. 11), pl. 7 (figs. 9-10), pl. 8 (figs. 5-8), pl. 11.
Habitat: A, B, F, H, Sigee 1.
The secondary utricles are very conspicuously inflated.

*Halimeda incrassata (Ellis) Lamx., 1812: 186; Hillis, 1959: 365, pl. 4 (figs. 1-2), pl. 5 (fig. 21), pl. 6 (figs. 21-24), pl. 12.
Habitat: below 25 fathoms and on hard bottom outside atoll, Barton, 1903; A, B, Sigee 75; A, B, F, Sigee 2b; F, Sigee 108.
The habitat data for these three specimens are listed here separately since the specimens appear morphologically dissimilar, but all three seem to fall within the circumscription of this species when examined anatomically. The surface utricles of specimen No. 2b are round in appearance and not angular as described by Hillis (1959). Aside from this, it seems to fall within this species.

*Halimeda opuntia (L.) Lamx., 1812: 186; Hillis, 1959: 359, pl. 2 (figs. 7-8), pl. 5 (figs. 3-4), pl. 6 (fig. 6), pl. 7 (fig. 3), pl. 10.
Habitat: below 25 fathoms and on hard bottom outside atoll, Barton, 1903; A, B, E, F, H, Sigee 2a, 3, 4.
These thalli are about 4-5 cm high with no specific holdfast present. The medullary filaments are fused in twos but occasionally may

be seen in threes, with the points of fusion about 1-1.5 times as long as the diameter of the filaments. The primary utricles adhere to each other even after decalcification. These individual utricles are about 17 μ in surface diameter.

Neomeris mucosa Howe, 1909: 84, pl. 1 (fig. 5) and pl. 5 (figs. 1-14); Dawson, 1956: 42, fig. 30c.
Habitat: F, H, Sigee 102.
Of the seven species in this genus, these thalli agree with the description and figures of this species as described in Howe (1909).

Tydemania expeditionis Weber-van Bosse, 1901: 139; A. & E. S. Gepp, 1911: 66, fig. 153-154; Taylor, 1950: 73, pl. 38 (fig. 1).
Habitat: B-D, J, Sigee 32.
Only the distinct glomerular form of this species is present in this collection.

Udotea orientalis A. & E. S. Gepp, 1911: 119 and 142; Taylor, 1950: 74, pl. 38 (fig. 2).
Habitat: A-F, H, I, Sigee 15.
The thalli are small, about 3-4 cm high including the stipe, and anatomically similar to the description in Taylor (1950).

Valonia utricularis (Roth) C. Ag. 1822: 431; Taylor, 1950: 41.
Habitat: F, H, Sigee 103, 111.
The vesicles are irregularly shaped with no organized pattern of branching.

Valonia ventricosa J. Ag., 1887: 96: Egerod, 1952: 347, pl. 29a.
Habitat: B-D, F, Sigee 52.
These vesicles are solitary, about one centimeter in diameter.

Phaeophyceae

*Dictyota bartayresiana Lamx., 1809: 43.
Habitat: in passage below 25 fathoms and on hard bottom, Barton, 1903.

Dictyota friabilis Setchell, 1926: 91, pl. 13 (figs. 4-7) and pl. 20 (fig. 1).
Habitat: A-F, H, J, Sigee 5a, 70.
Both collections form prostrate clumps, with the thalli about 1-2 cm long. Most of the thalli of No. 70 are less than 2 mm broad, whereas the thalli of No. 5a are about 5 mm broad. For the present, both of these sterile specimens are tentatively listed here.

Dictyota sp.
Habitat: A-F, H, J, Sigee 5b.
This collection consists of prostrate clumps with the thalli up to 3 cm long. The margins of the thalli are serrated as in Dictyota patens J. Ag., but do not conform to the growth habit and size of this species.

Hydroclathrus clathratus (Bory) Howe, 1920: 590; Taylor, 1950: 96.
Habitat: E, F, I, Sigee 45.

Padina commersonii Bory, 1828: 144; Okamura (Icones VI): 89, pl. 295.
Habitat: A, B, E, G, Sigee 17.
These thalli are about 5 cm high and arise from a common holdfast. The thalli are two to three cells thick, about 90 μ in thickness at the apical portion and enlarging to 120 μ in thickness below. The oogonia are in concentric rows on the upper surface above every hairline, with no inducium present.

Pocockiella variegata (Lamx.) Papenfuss, 1943: 469, figs. 1-14.
Habitat: B, D-F, H, Sigee 50.
The thalli were growing prostrate on fragments of coral. Although the anatomical sections as well as habit are similar to those described in Papenfuss (1943), there is still some doubt as to the legitimacy of the generic name.

Sphacelaria sp.
Habitat: A, B, Sigee 28.
These thalli are about 1-2 mm high. Since all of the thalli were without propagulae, no specific epithet can be designated here.

Turbinaria ornata (Turner) J. Ag., 1848: 266; Taylor, 1950: 101, pl. 53 (fig. 2) and pl. 55 (fig. 2)
Habitat: B, F, H, I, Sigee 20.

Rhodophyceae

The melobesioid corallines of the present collection are not reported here because of the authors' unfamiliarity with this group. However, two species described in Foslie (1903) are listed here.

Antithamnion sp.
Habitat: B, C, F, Sigee 25.
The branches on the main axis are either opposite or verticillate with the terminal branches tipped with a single acute shaped cell.

*Archaeolithothamnion schmidtii Fosl.
Habitat: below 25 fathoms of water in lagoon, Foslie, 1903.

Botryocladia skottsbergii (Boerg.) Levring. 1941: 645; Dawson, 1956: 52, fig. 48.
Habitat: A-C, F, Sigee 23.

Ceramium fimbriatum Setchell & Gardner, 1924: 777, pl. 26 (figs. 43 & 44); Dawson, 1944: 317; Dawson, 1950: 123.
Habitat: G, Sigee 105.
The mature portions of the thalli are approximately 70 μ in diameter, with the corticating bands divided into two distinct parts at about the lower third. Short thick apically rounded, unicellular hairs are present at the nodes. The tetrasporangia are involucrate.

Ceratodictyon spongiosum Zanard., 1878: 36; Okamura, 1909 (Icones II): pls. 51-52.
Habitat: I, Sigee 69.
The thalli are very sponge-like in appearance.

Champia parvula (Ag.) Harvey, 1853: 76; Boerg., 1915-20 (Danish West Indies): 407.
Habitat: A, Sigee 122a.
The thalli are intertangled and form small clumps about 2 cm across.

Champia salicornoides Harvey, 1853; Taylor, 1960: 491, pl. 61 (fig. 5).
Habitat: A, Sigee 122b.
The thalli are about 3 cm high and appear erect from a basal disk. Anatomically, the walls of the thalli consist of a single layer of large cells, 25-50 μ in diameter, interspersed with smaller cells about 7-14 μ in diameter. The medullary filaments are seen running throughout the length of the thalli. The sessile pericarps are conical in shape and scattered on the thalli.

Dasya sp.
Habitat: H, Sigee 112.

Dictyurus purpurascens Bory in Belanger & Bory, 1846: 170, pl. 15 (fig. 2); Taylor, 1950: 143, pl. 78 (fig. 1).
Habitat: B, Sigee 24.
This collection is similar to the description and photograph in Taylor (1950).

Galaxaura marginata (Ellis & Solander) Lamx., 1816: 264; Kjellman, 1900: 77, Tab. 20 (fig. 44).
Habitat: B, C, Sigee 104.
The thalli are composed of flattened branches throughout. Terminal cells of the cortical filaments are spherical in shape.

Galaxaura rudis Kjellman, 1900: 43-44, Tab. 2 (figs. 1-9) and Tab. 20 (fig. 11).
Habitat: A, B, D, F, Sigee 21.
The thalli are 3-4 cm high and are bushy in appearance. Anatomically, the thalli consist of long assimilatory filaments with swollen cells at the basal portion of these filaments.

Gelidium divaricatum Martens, 1866: 30, pl. 8; Tseng, 1936: 36, figs. 18a-b, pl. 4.
Habitat: A-D, F, J, Sigee 72.

Griffithsia sp.
Habitat: C, Sigee 80.
The thalli are sterile and about a centimeter long.

Herposiphonia sp.
Habitat: B, D, H, Sigee 78.
These thalli were growing as epiphytes on Halimeda opuntia.

Hypnea spp.
Habitat: E, Sigee 91; E, F, H, Sigee 93; A, B, E, F, Sigee 18; B-D, Sigee 12.

Four species are represented in these collections of Hypnea. Due to the taxonomic difficulties encountered by the senior author in this genus, they cannot be named at present but are listed separately above with their respective habitats.

Jania capillacea Harvey, 1853: 84; Boerg., 1917: 198-199, fig. 188.
Habitat: A-F, H, Sigee 11.

The thalli appear as intertangled masses, with the branches seldom forming obtuse angles at the dichotomies. The diameter of the branches is approximately 120 u, with the length of the segments 6-8 times as long as the diameter.

*Lithothamnion fruticulosum (Kützing) Fosl.
Habitat: below 40 fathoms, Foslie, 1903 (cited as an uncertain determination).

Lophosiphonia villum (J. Ag.) Setchell & Gardner, 1903: 329.
Habitat: B-D, F, H, J. Sigee 29, 98.

Polysiphonia ferulacea Suhringar in J. Ag., 1863 (Spec. Alg. II): 980.
Habitat: A-C, E, F, I, Sigee 35a.
Species determined by Dr. Hollenberg.

Spyridea filamentosa (Wulf.) Harvey in Hooker, 1833: 337; Taylor, 1950: 139; Dawson, 1954: 444, fig. 54i.
Habitat: E, Sigee 97.

The main axis is similar to the illustration in Dawson (1954). The determination branchlets are tipped with a single spine.

Tolypiocladia glomerulata (Ag.) Schmitz in Schmitz and Hauptfleisch, 1896-97: 441; Dawson, 1954: 452, figs. 59b-c.
Habitat: B, C, Sigee 44.

Vidalia serrata (Suhr.) J. Ag., 1863: 1125.
Habitat: B, Sigee 19.

The thalli are about 2 cm high with the stichidia present on the blades, just inside of the marginal serrations.

FRESHWATER AND TERRESTRIAL ALGAE

Nostoc commune Bornet & Flahault
Habitat: Terrestrial, Gan Island, Sigee 119

This blue-green alga was reported to be especially evident in wet weather.

Pithophora oedogonia (Mont.) Wittrock, 1877: 55, pl. 6 (figs. 1-6); Collins, 1909: 363.
Habitat: Freshwater, Gan Island, Sigee 114.

The filaments of this green alga are branched with cells about 60 u wide and the cell length about ten times as long as the diameter. Both intercalary and terminal akinetes are present.

Summary of Algal Collection

Excluding the four tentative species of Hypnea, this paper lists 63 species or varieties of marine benthic algae from Addu Atoll, 58 of them reported here for the first time from this atoll. These new records consist of 7 in the Myxophyceae, 25 in the Chlorophyceae, 7 in the Phaeophyceae, and 19 in the Rhodophyceae. One terrestrial alga and one freshwater alga are also included in this paper.

It is of great interest to note that the species represented here from Addu Atoll in the Indian Ocean are very similar to the marine flora that occurs on many of the atolls in the Pacific Ocean.

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